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## FOREST SERVICE.

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### SILVICAL LEAFLET 18.

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#### REDWOOD.

*Sequoia sempervirens* (Lamb.) Endl.

The gigantic size of redwood and its immense yield of wood per acre set it apart from all other timber trees in the world. The wood has many very valuable qualities; its resistance to insects and fungi, its lightness, ease of working, straight, fine, even grain, handsome color, and slowness in burning make it peculiarly adapted to a large number of uses, especially house construction, interior finish, shingles, railroad ties, posts, poles, shakes, and staves.

The redwood and its near relative, the bigtree, are the sole survivors of a genus which was once widely distributed. Fossil specimens of *Sequoia* have been found in Greenland and in northern Europe, but since glacial times the redwood has existed only in a narrow strip along the Pacific coast, and the bigtree has been confined to a few groves in the California Sierras.

The redwood has one characteristic which is unique among conifers—it sprouts vigorously. This makes it an easy tree to manage, and in spite of the difficulty of securing good seedling reproduction, there should with proper care be no difficulty in perpetuating it, and it should prove one of the most profitable of all forest crops.

#### RANGE AND OCCURRENCE.

Redwood is found along the Pacific coast from the Chetco River in southern Oregon to Salmon Creek Canyon, Monterey County, Cal., a distance of about 500 miles, and rarely extends more than 30 miles from the sea. Its altitudinal range is from sea level to 2,500 and occasionally 3,000 feet.

Commercial redwood occupies a belt from 4 to 25 miles wide from the southern boundary of Oregon to southern Mendocino County, Cal., an area of about 1,900 square miles, but it is most abundant and attains its largest size at low altitudes north of Cape Mendocino. There are a few groves of commercial trees south of this belt, and isolated groups of little value are found in sheltered canyons near the coast as far south as the southern limit of the tree's range in the Santa Lucia Mountains of Monterey County.

The best stands are found on the flats and benches along the larger streams, on moist coastal plains, river deltas, moderate westerly slopes, and valleys opening toward the sea. With increase in altitude, in dryness, or in steepness of slope the trees become smaller and gradually yield ground to other less exacting species. In the southern part of its range, redwood is restricted to western exposures; in the north it frequently crosses to the eastern side of the watersheds.

#### CLIMATE.

Redwood is closely confined to humid regions with frequent and heavy ocean fogs. Wherever the trees occur outside the influence of these fogs they are scattered and small. By hindering evaporation and transpiration the fogs conserve the moisture in the soil and in the trees. The soil of the redwood forest is therefore fresh, and the air about it moist at a time of year when most of California is dry.

The temperature of this region rarely goes below 15° F. or above 100° F. and the average yearly temperature is from 50° to 60°. The annual precipitation varies between 20 and 60 inches, mostly in the form of winter rains. Snow lies only on the tops of the highest ridges.

#### ASSOCIATED SPECIES.

Only a relatively small portion of the redwood forest forms pure stands. These occupy low, protected, and level or gently sloping situations, and cover an aggregate area of less than 50 square miles. By far the greater part of the forest occupies the sides of the Coast Range, and is a mixture of redwood, Douglas fir, tanbark oak, white fir, giant arborvitæ, western hemlock, and madroña.

In the upper part of its altitudinal range and on steep slopes redwood is at its poorest and grows sparsely. In the descent of the mountains toward the ocean, as the slopes become moderate, the atmosphere more humid, and the soil deeper and fresher, redwood steadily gains on the other species and the forest becomes denser until on the rich river flats the redwood reaches its maximum size and density in practically pure stands, with only occasional scattered trees of Sitka spruce, Port Orford cedar, western hemlock,



and lowland fir. These thick forests contain little undergrowth except moss, oxalis, and bracken fern. In the more usual form of the forest, on the slopes, however, the slant of the ground and the uneven heights of the different species in mixture admit enough light to render these redwood stands comparatively open. So that, except where fires are frequent, there is a dense growth of huckleberry, salal, Oregon grape, thimbleberry, and ferns.

Of all the associates of redwood, Douglas fir is the most abundant and important, and grows with it everywhere except on damp flats and in gulches. On the upper slopes Douglas fir and tanbark oak are its characteristic associates, and hemlock on the lower. Other species which grow in mixture with it are Pacific yew, California torrey, knobcone pine, California laurel, cascara buckthorn, red alder, and Gowen cypress. These species are usually beaten in the struggle for growing space by redwood, which is climatically the most favored, but each finds places here and there where the conditions enable it to hold its own. The proportion of trees in mixture with redwood over the greater part of its range does not exceed 25 per cent.

#### HABIT.

The normal mature redwood tree has a straight, slightly tapering bole, a clear length of more than 100 feet, and a pyramidal crown of short, horizontal branches which occupies a third to a half of the total height of the tree. Old trees vary from the normal habit and may have a crown of a few long, flat branches or a mass of little, bushy branches reaching down the whole length of the bole. Many old trees have burls or other protuberances on the stems caused by the healing over of wounds. The bark is reddish gray, fibrous, and very thick on large trees, and is fissured so as to produce a fluted appearance. Redwood has no tap root, but its large and numerous lateral roots strike down into the soil at a sharp angle, giving the root system the shape of an inverted funnel.

Redwood is the tallest tree of America and reaches a height of 350 feet and a maximum diameter of 20 feet. These dimensions, in fact, are not unusual on the flats; on the slopes the tree is rarely more than 225 feet high and 10 feet in diameter.

#### SOIL AND MOISTURE.

Redwood is very exacting in its moisture requirements. It makes small demand upon the soil except in this regard, though it prefers deep to shallow soils, and grows better in fresh, well-drained situations than in boggy places. The prevailing rock within its range is a sandstone, and the soil has a clayey to sandy consistency with a capacity for holding much water, feels greasy when wet, and is yellowish in color.

Even on the steep slopes it is usually of fair depth and of good composition, and varies from clayey to a sandy loam, but on upper slopes with south or southwest exposures it is usually thin and light, while next to the ocean it is apt to be sandy. The soil near the mouths of streams is often of a boggy nature, ill-suited to the redwood, and supports instead an irregular forest of Sitka spruce, lowland fir, Port Orford cedar, and hardwoods.

#### TOLERANCE.

Except in early youth, redwood will endure a moderate amount of shade. It does not, however, require shade, and its most rapid growth is made when it is exposed to abundant sunlight. It possesses several of the characteristics of intolerant trees; its crown is almost as thin and open as that of larch; in mixed stands its branches die off more rapidly than those of its companions; its crown bends eagerly toward openings where light enters the crown cover; and its seedlings demand an abundance of light. In spite of these signs of light requirement, redwood forms one of the densest forests known. Its sprouts exhibit in a marked degree a capacity to recover from suppression. Supported and nourished by the full-grown roots, they may exist under the densest shade for 100 years. They grow very slowly in diameter during this time, but recover completely and make rapid growth when they are again exposed to the light. The tolerance of the sprouts varies with soil moisture. On the bottoms the tree can stand so much shade that other species are usually driven out of competition for the ground. On the hills, where there is less moisture and more light, redwood usually gives way to the less tolerant Douglas fir and to such drought-enduring species as tanbark oak and madroña.

#### GROWTH AND LONGEVITY.

The growth of redwood is moderately rapid. Though the annual rings are narrow in old trees, the total annual volume production of wood is large by reason of the great diameter and height of the tree. A study of second growth shows that under fair soil conditions and in a dense stand second-growth poles in 30 years will be from 12 to 16 inches in diameter and from 70 to 80 feet high. The great age of 1,373 years has been recorded for redwood, but 500 years may be considered its mature age. After this it begins to die at the top and fall off in growth.

The yield of redwood on the slopes, where the bulk of the forest grows, is from 10,000 to 75,000 board feet per acre; in exceptional instances 400,000 feet per acre have been cut. In the limited forests on river flats, where the tree reaches its best development in dense, practically pure stands, yields of more than 1,000,000 board feet per acre have been obtained.



## SUSCEPTIBILITY TO INJURY.

Redwood is peculiarly free from enemies. It is rarely wind-thrown, and the old trees are so covered with fire-resistant bark that they are damaged by fire less than any of their associates and then only by the burning of the humous cover of the soil. Young stands, however, may be killed outright by severe ground fires. The tree is singularly free from fungous diseases, and it is because of this quality, largely, that it is able to reach such great age. Brown rot, the only disease of its trunk now known, sometimes attacks the wood at the base of the stem, but does little harm. The tree is, furthermore, not subject to serious attack by any insect.

## REPRODUCTION.

By far the greater part of the reproduction of redwood is by sprouts, which spring from the stump and root collar, or as suckers from the roots. It is the only conifer the sprouting capacity of which is silviculturally important. In this respect it even excels most hardwoods, for its sprouts not only grow very rapidly, but are long lived, become very large and of good form, and develop very dense stands. Redwood is also peculiar in its ability to produce excellent sprouts from very old stumps.

The seeds of redwood are matured in two seasons and are released from the cones and scattered by the wind in the autumn. Though a fairly prolific seed bearer, the tree does not reproduce itself abundantly by seed. Only a small proportion of the seed, from 15 to 25 per cent, will germinate even under the best conditions. The seedlings, in contrast to sprouts, are of very slow growth and require full light, so that even the few seedlings which do germinate seldom find conditions which enable them to survive the competition for light with sprouts and with other more tolerant seedlings.

## MANAGEMENT.

The form of management to be used with redwood is the coppice method, a system unique in the management of conifers. In pure stands of redwoods the sprouts and suckers which come after cutting, and in mixed forests the sprouts of redwood, together with the seedlings of Douglas fir and other species, will be quite sufficient to restock cut-over tracts. It is very necessary, however, to exclude fire from the area under reproduction until the sprouts have reached a size at which they can not be killed by fire. In the removal of the old stand care should be taken not to destroy the smaller trees—for example, those under 20 inches on the stump—for though at present unmerchable, they are valuable, both for a future cutting and for protection against washing rains and drying sun and winds.

